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MODERN DESIGN OF GENERAL CARGO MARINE TERMINALS

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MODERN DESIGN OF GENERAL CARGO MARINE TERMINALS

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One of the most overworked words in our vocabulary today is the word "modern." Even more, the words "modern design" have become the catch-words of every advertising copy writer, whether describing houses, baby carriages, or pretzels. That these words are used so much can most probably be ascribed to their lack of exact meaning. The artist, the engineer, the architect, the economist --- each has his own idea of what constitutes "modern design."

As far as a general cargo marine terminal is concerned, "modern design" is judged strictly from a utilitarian point of view. Whether it is constructed wholly of prestressed concrete, or whether it is pleasing to the eye, or even whether it is new --- none of these makes a cargo pier modern. A marine terminal can be said to be modern only when it is so constructed that it can efficiently and expeditiously accommodate the latest developments in the water and land transportation systems that it serves and also provide for full use of the latest techniques in materials handling.

Functions of a General Cargo Marine Terminal

The principal function of a general cargo marine terminal is to act as an interchange point for cargo moving via a combination of land and sea transportation routes. The transit shed, typically the only superstructure of consequence, takes its name from this function. Here cargo is received, sorted, consolidated, and generally processed for exchange between one form of transportation and another, not stored for an indefinite period.

There are two basic forms that a marine terminal can take, namely, the finger pier and the marginal wharf. The finger pier, as the name suggests, is a long, narrow structure jutting out into the water perpendicular to the shoreline. This type of construction is the most common in American ports and comprises the bulk of the piers in New York Harbor. In those ports where easily developed water frontage is at a premium, as it is on the island of Manhattan in New York Harbor, the finger pier is the type of pier most often used. With this type of construction, a given length of waterfront can be made to yield the maximum number of ship berths.

The second basic form of pier is the marginal wharf. The marginal wharf is constructed parallel to the shore and is employed where there is no shortage of easily developed waterfront space or where the waterway adjacent to the pier is too restricted to permit the use of the finger pier.

Whether the finger type or the marginal wharf type pier is used depends on the economic geography of the particular port. There is no intrinsic advantage in either type as far as modern design is concerned.

Factors Governing the Design of a Modern General Cargo Marine Terminal

At the outset let us recognize that there will always be a certain number of piers in a port that are of obsolete design. Marine structures are usually built

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for long life, with an amortization period of 40 years or more, and long before a pier has suffered any fatal physical deterioration, it is likely to be behind the times. Fault can only be found when new piers are built and the design features of the old pier are merely copied.

Perhaps the best way to open a discussion of the design requirements for a modern general cargo terminal is to review the changes that have taken place in the last 50 years in ocean and land transportation and in materials handling techniques. If a pier is built to accommodate a horse and wagon when the motor truck has long since taken the horse's place, the pier certainly cannot be considered modern. Again, if a pier is built to provide space to accommodate the cargo of a ship the size of a sailing ship, that pier cannot be considered modern.

One of the most revolutionary changes during this period has been the development of the motor truck. As recently as 25 years ago, the motor truck was not an important element in our transportation system. Today, it is as important as the railroad in many ways. In connection with the transportation of oceanborne cargo to and from piers, the motor truck is now carrying as much as 50 percent of the cargo, for either local delivery or long-haul transportation. Moreover, it is still growing as a factor in the land transportation of freight having overseas origin or destination. Conversely, railroad freight appears to be declining in relative importance in the carriage of cargo to and from marine terminals.

Ranking in importance with this development of the motor truck is the development of labor saving devices for cargo handling such as fork lift trucks, small mobile cranes, and other equipment for use on the wharf proper. The baling hook, the hand truck, and the longshoreman's back muscles, while they are still in use today, are no longer the principal elements of the materials handling system, as they were 50 years ago.

The ship itself has also grown during the past half century. Although overall size has not shown any striking increase, there has been a great increase in cubic capacity for a given size of a ship. This means that a ship of a given length and draft is carrying up to 100 percent more cargo in its holds today than it did 50 years ago. The speed of the ship has also increased but not radically enough to be of direct importance to the design of the general cargo terminal.

Another important change affecting the design of the cargo terminal has been the development of rapid communication methods. Today the importer can telegraph anywhere in the world to order whatever goods he desires. The frequency of sailings, the speed of ships, the rapidity of communications, and the reliability of sailing schedules have made it unnecessary for the importing merchant to maintain large inventories. Not only does this require a different concept of merchandising, it also requires a different concept in the design of the marine terminal.

There are other changes that have taken place in the past 50 years, but these that I have enumerated are the principal elements which affect the construction and design of the modern cargo terminal. Each of the changes, in turn, has produced various offshoot developments which also have to be considered in pier design. I shall attempt to show how these developments affect and actually create the design criteria for the cargo pier.

Development of Modern Standards

As I have said, the over-the-road truck is now the most important single element to be considered in the design of a general cargo marine terminal.

If the terminal is of the finger-pier type, it is not only necessary to provide cargo and working space on the pier, but it is also necessary to provide an unimpeded roadway for truck egress and ingress. Even before cargo space is considered, therefore, the modern cargo terminal requires greater dimensions than the typical terminal designed a generation ago. If the construction is of the marginal wharf type, truck back-up spots must be provided on the inshore side of the shed. In this form of terminal construction, it is desirable to provide loading platforms at the height of the truck tail gates to eliminate unnecessary lifting of cargo in the truck loading operation.

The increasing use of over-the-road trucks also demands a considerable amount of careful planning of the general layout of the upland area. Sufficient space and adequate traffic control must be provided for the waiting lines of trucks coming to the pier to pick up or to deliver cargo. The amount of space that is necessary for such waiting lines is minimized if the pier itself can assure quick dispatch to loading or discharging trucks.

The motor truck dimensions and the space required for maneuvering may be controlling factors in the spacing of columns, and the vertical clearances of beams and doors are also affected by the vehicle height.

The increasing use of the truck has also cut into the proportion of cargo moved by rail. This has resulted in a reduced need for extensive rail facilities at the terminal. This is not to say that rail facilities may be ignored but merely that rail transportation is no longer the dominant means of moving cargo to and from a marine terminal for general cargo. Further, the diminishing use of rail also means that there is a diminishing proportion of direct transfer from rail or lighter to ship. Cargo that once moved in this fashion, without even temporary storage at the terminal, must now be accommodated in the transit shed, increasing the required pier space still further.

The great number of labor saving devices that have been introduced into the handling of cargo constitutes the second major factor affecting pier design. The first and most notable of these devices is the fork lift truck. The introduction of this piece of equipment has revolutionized the entire system of handling general cargo. Instead of manhandling each item as was done in the old days, cargo can now be assembled on pallets and carried a ton or more at a time from the side of the ship to the place of storage on the pier and vice versa. With the use of fork-lift trucks, cargo can now be stacked as high as 20 feet, whereas before, it could be piled only as high as the longshoreman could reach. This has a two-fold effect on the design of the pier, namely, the overhead clearance requirement has been increased and the load-bearing capacity of the wharf must be much greater. To provide fully for the use of the fork-lift truck, the cargo pier must also have a smooth, or at least even, deck surface, uninterrupted aisles, and adequate aprons.

The changes that have taken place in the ships that are served by general cargo terminals have not been as radical as the changes taking place in land transport and in materials handling techniques. The most notable change in the ships in the last 50 years has been an increase in the amount of cargo it can carry. A ship hull carried not much more than half the cargo 50 years ago that a hull of the same type does today. This increased volume of cargo carried in a single ship necessitates the provision of greater amount of shed space to assure satisfactory terminal operation.

Finally, a profoundly important change has taken place in the field of communications. The trans-Atlantic cable, the world-wide radio network, and the greater speed of ships have tended to cause a marked change in merchandising practices. This change, in turn, has affected the facilities needed at the

waterfront for the receipt and shipment of overseas cargoes. The ease with which goods can be ordered from any part of the world with assurance of delivery within a reasonably short time has caused merchants to depend less on their own stocks to supply customers. They no longer need to maintain large inventories to assure ability to deliver the goods as needed. This has had a two-fold effect on waterfront facilities. The first has been the diminishing need for waterfront warehouse space. We have seen the steady decline, especially in the past 10 years, in the use of warehouse space along the waterfront. The second effect has been on the typical size of the cargo shipment arriving at the pier. The custom of many merchants ordering small amounts of goods creates a situation in which a ship carries an enormous variety of items on its manifest, a far larger number for a given tonnage than characterized ocean shipping of the nineteenth century. The pier, therefore, must provide sufficient space to accommodate the sorting, separate stacking, and consolidation of these shipments. In other words, space requirements are increased even on a per-ton basis.

Current Standards

Using the C-2 vessel as typical of the American ships likely to be berthed at a pier today and taking into consideration the developments described above, minimum standards can be established for the controlling dimensions of the modern general cargo marine terminal. The ship berth should be at least 550 feet in length and should have a depth along side of 32 to 35 feet at mean low water. The slip between two adjacent piers should be at least 250 feet wide. If two or more ships are to be berthed at either of the piers, a still greater slip width, 300 feet or more, is needed.

Making allowances for the factors enumerated above, it has been calculated that a minimum shed space of 90,000 square feet is required for each ship berth. The apron of a pier should have a minimum width of 15 feet, unless it bears rail tracks when its width will depend on the number of tracks to be installed. The overhead clearance within the shed must be at least 20 feet, the floor loading capacity must be between 500 to 600 pounds per square foot, and the doors must be of adequate height to accommodate over-the-road trucks and all of the various cargo handling devices used on the pier. Besides these strategically important dimensions, the standard items of any construction such as illumination, fire protection, and sanitation facilities must also be provided in accordance with modern thinking in those fields.

The 90,000 square foot requirement for shed area for each ship berth can be explained as follows:

Freight rates on oceanborne cargo are computed on the basis of "weight" tons and "measurement" tons. A long ton of cargo that stows in less than 40 cubic feet is known as "weight" cargo and freight is charged at so much per weight ton. The lighter commodities, those that occupy 40 cubic feet or more per long ton, are referred to as "measurement" cargo and freight is charged on a measurement ton basis of 40 cubic feet to the ton.

The general cargo which is shipped through the Port of New York averages about 70 cubic feet to the long ton; therefore, most of it is shipped as measurement cargo.

After careful studies, it was found that the typical dry cargo ship calling at a New York terminal loads and discharges about 12,500 measurement tons. Half of this cargo is discharged from the ship, the other half is loaded. Since the ship must be discharged first, then loaded, the transit shed must be designed to accommodate both inward and outward cargoes at the same time.

These 12,500 measurement tons occupy 500,000 cubic feet and this is the volume for which storage space must be provided within the shed. Most of this cargo can be palletized and stacked three tiers high. These three tiers will reach about 15 feet in height, less six inches for each of the three pallets, or a net height of about $13\frac{1}{2}$ feet. The floor area requirement, therefore, would be 36,000 square feet if all stacks were full height. But some stacks will be short, because of broken lots. To allow for the inevitable lost space, the 36,000 square feet theoretically required is raised by 25 percent, to 45,000 square feet. Another 45,000 square feet will be required for working aisles, for truck roadways, and truck loading spots. The total gross area requirement of 90,000 square feet per ship berth is the figure that has been adopted by The Port of New York Authority as the minimum for a modern general cargo berth and which has been applied to the design of its new marine terminal facilities.

The area requirement stated above includes provision for 30 truck berths, each 40 feet by 12 feet, for loading and unloading. That number is based on the assumption that the 12,500 measurement tons of cargo are delivered to or taken from the pier in five working days. It also assumes that half the cargo moves by truck and that the average truck load is ten measurement tons. This amounts to 1,250 measurement tons a day, moving in 125 trucks. For an eight-hour day this means that about 16 trucks must be handled every hour. Since it takes almost two hours on the average to load or unload a truck, about 30 available truck spots for each berth are needed.

Obviously, terminals cannot be standardized in design. There is ample reason for considerable variation, not only as between ports but even between different areas within the same harbor.

The choice of finger pier or marginal wharf depends primarily upon the geography of the available waterfront. Where the dominant movement of freight is by rail, trackage facilities will have to be given more prominence and motor vehicle roadways less. Although the 90,000 sq. ft. figure for the transit shed is valid for a terminal at which an entire ship load is to be handled, in the smaller ports where ships load and discharge only part cargoes, or at some terminals within a major port, a proportionately smaller figure can quite properly be used.

Modern Design Illustrated

Several examples can be cited to illustrate the varieties of design that are possible while still meeting modern criteria. Among recent developments in New York are the Hoboken-Port Authority piers and the new terminals developed at Port Newark. One of these projects uses the finger-pier plan while the other utilizes a marginal wharf. Each, by a different approach, has been designed to handle the new large ships and to accommodate comfortably trucks, freight cars, and lighters. Both projects called for single-deck transit sheds with 90,000 square feet or more gross shedded area per berth and the other standards discussed in the foregoing paragraphs have been applied in design. The Port Authority's new Pier C at Hoboken, a two-berth facility, is 700 feet long and 328 feet wide. This is probably one of the most spacious two-berth piers in the United States. One apron of this pier is 20 feet wide, while the other, which bears one railroad track, measures 25 feet. The shed has a center well 500 feet long to accommodate two depressed railroad tracks and it also has a U-shaped two-lane truck boulevard surrounding the center well to permit one-way truck movement.

The cargo pier development at Port Newark, on the other hand, follows

the quay-type construction. There, a minimum length of 550 feet is allowed for a ship berth, the apron measures 50 feet and bears two railroad tracks. The rear of each shed has a tail-gate-high freight platform abutting on a 100-ft. wide paved roadway and two rail tracks laid flush with the surface.

The Hoboken and Port Newark facilities are both new and modern. On the other hand, several good examples of modernization can be cited whereby existing obsolete piers have been modified to conform to the needs of modern transport methods. In San Francisco Harbor, for instance, two existing piers, 680 feet long and 203 feet wide, have been joined by a pile-supported platform which occupies what was formerly the 222 ft. intervening slip. The center portion of the platform, 150 feet wide, was designed as a depressed well for truck maneuvering and back-up and for rail track accommodation. The remainder of the slip width was utilized for pier and shed widening. The terminal now provides three generous berths, one on each side and a third across the end. The entire facility is leased to the Matson Navigation Company which operates general cargo and passenger ships in the trans-Pacific service, and it has been in operation since January 1952.

Other illustrations can be cited of modernization of older facilities so as to make provision for motor trucks, fork lift trucks, and the other important developments in cargo handling.

Specialized Cargo Facilities

There are certain specific commodities which are transported along regular routes in sufficient quantities to justify specialized facilities designed for the handling of that commodity alone. Bulk liquids, such as petroleum products, can be pumped into and out of ships' tanks, bulk ores and grain can be gravity loaded into ships' holds through chutes and unloaded by giant 20-ton cranes, while stems of bananas can be unloaded by endless belts and other special machinery. Two especially interesting facilities in New York Harbor are the Daily News newsprint terminal in Brooklyn, and the United Fruit Company's banana unloading terminal in Weehawken, New Jersey.

At the newsprint terminal a permanent crew of 28 men operate a system of conveyor belts, hoists, and specially-designed fork-lift trucks to handle rolls of newsprint moving to the terminal by ship, barge, and box car and from the terminal to the plant via truck. Longshoremen unload the ship and place the newsprint rolls on the conveyor system at shipside. All of the Daily News' requirements of about 1,000 tons of newsprint each working day move through this facility.

The Weehawken Interchange Terminal, as the banana unloading terminal is called, is designed to facilitate the rapid and safe transfer of stems of bananas from steamships to refrigerated cars and trucks. Four specially-designed traveling cranes housing endless belt conveyors transfer the stems of bananas from the ships hold to an extensive system of horizontal belts called "curveyors", which run between strings of refrigerated cars and over-the-road trucks. A crew of 330 longshoremen can transfer a shipload of 60,000 stems of bananas from a ship to rail cars or to motor trucks in an eight-hour day.

Each of these facilities is new, the newsprint terminal was completed three years ago, and the Interchange Terminal two years ago; and each is modern, designed around a materials handling system tailored to fit the specific needs of one industry.

CONCLUSION

I have endeavored to present in this paper a concept of modern general cargo terminal design. Whenever a terminal becomes a bottleneck to cargo movement, it cannot be considered modern. Modernity consists simply of integrating the cargo pier into the system of handling cargo from and to the oceangoing vessel.

Even though I have presented the criteria for what I should call a modern facility, I should like to repeat that terminal design, of course, cannot be standardized. My main purpose has been to emphasize the factors of modern transportation technology that should govern the design. I want also to emphasize that we must expect transport technology to continue to advance and that terminal design must be correspondingly progressive.

Finally, let me summarize it all by saying that the modern cargo terminal is one that is in functional harmony with modern transportation techniques and practices.

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